Non-Linear Tariffs & Consumption
Evidence from a Natural Experiment on Water in France

Alexandre Mayol (PSE)
Simon Porcher (Sorbonne Business School)
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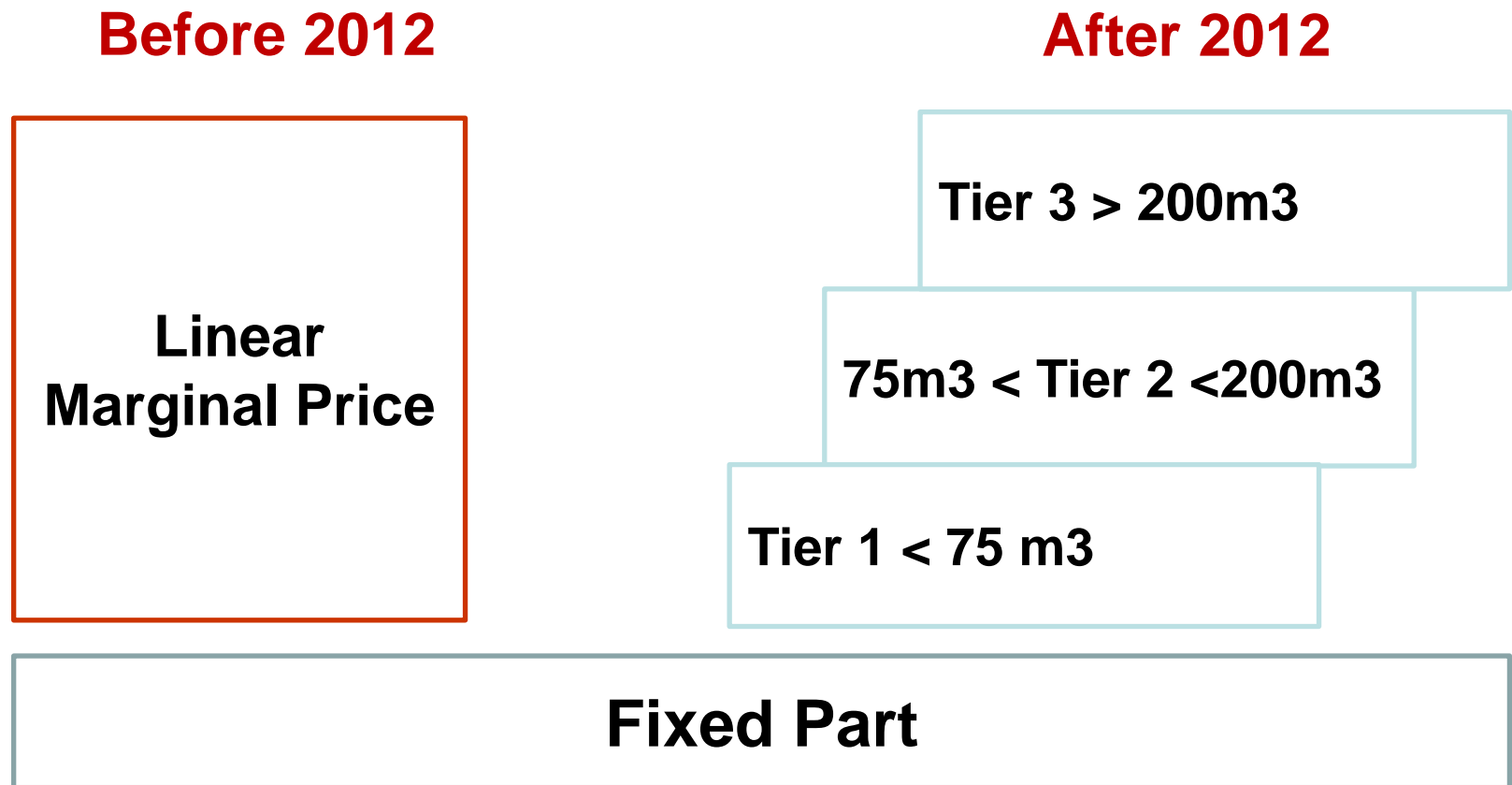
Water Provision in France

- In France, municipalities must provide local public services on behalf of their citizens:

    - These public services can be managed in-house or contracted out to a private operator;

    - There is no national regulator: municipalities monitor prices, control entry and exit of operators and ensure uninterrupted service.

Water Tariffs in France

- Tariffs are designed in order to

  - Cover costs, i.e. 'Water pays water';
  - Promote affordability and access in price;
  - Promote sustainable consumption.

- In France, since 2013, experiments on social tariffs in energy & water are encouraged ('Brottes' Law, 2013) via

  - Incentives such as rebates or subsidies;
  - Non-linear tariffs.

Natural experiment

• 'Eau du Dunkerquois' (more than 200, 000 inhabitants) in the North of France set up a new tariff based on three tiers

Before 2012

Linear
Marginal Price

After 2012

Tier 3 > 200m3

75m3 < Tier 2 <200m3

Tier 1 < 75 m3

Fixed Part

Research questions

- What is the impact of non-linear tariffs on consumption ?

  – Which goals do these serve?

  – Are consumers sensitive to price change?

  – What are the basic welfare economics of these price changes?

  – Can we design an optimal multi-tier tariff based on what we observe?

Research questions

- What is the impact of non-linear tariffs on consumption ?

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  - What are the basic welfare economics of these price changes?
  - Can we design an optimal multi-tier tariff based on what we observe?

Main findings of the paper

1. Linking consumer behavior & pricing:
    – Consumers react to both marginal & average pricing;
    – Price elasticity is significantly high compared to previous results.

2. Quantifying the impact on allocative efficiency:
    – Our elasticity estimation yields high efficiency costs of non-linear pricing;
    – Transfers could probably be more efficient than non-linear tariffs to ensure redistribution;
    – Also raises questions in terms of water sustainability (does the deviation from marginal pricing equal the externality?)

Contributions

1. Theoretical contributions:

    – Consumers are rational (i.e. increase consumption when price decreases / bunch around kink points);

    – Price is a good signal to reduce consumption (i.e. extrinsic motivations).

2. Empirical contributions:

    – Evaluation of increasing block-tariffs using a natural experiment.

Takeaways for managers

- Managers can design tariffs which have social impacts & can use tariffs to promote a sustainable use of water.

- However, non-linear tariffs have potentially strong efficiency impacts.

- Important to run experiments to measure the impact of tariff changes on consumption.

Theoretical motivation

- Landmark papers on optimal tariffs by Pigou (1946) and Ramsey (1947) + Boiteux (1956)

- Massive literature in economics on the impact of

  - tax rates on labor participation (Saez 1999) & self-reporting (Saez 2010, Chetty et al. 2010)

  - marginal price on natural gas consumption (Borenstein & Davis 2012), electricity (Ito 2013), water (Ito 2014)

Theoretical motivation

- Standard theory of nonlinear budget constraints show that

    - Indifference curves would intersect the kink points of the nonlinear budget constraint

    - As a result, there is a bunching of consumers across the kink points of nonlinear price schedules
        - See Saez (1999), Saez (2009), Chetty et al. (2010)

- Alternative theory: 'schmeduling' (Liebman & Zeckhauser 2004)

Dataset

- Unique dataset collected via Suez & Eaux du Dunkerquois

  - Representative panel of 1387 households in 2009-2013
  - Variables: consumption, price, house/flat, pluviometry, household size, district, city.

- Some drawbacks

  - Unbalanced panel
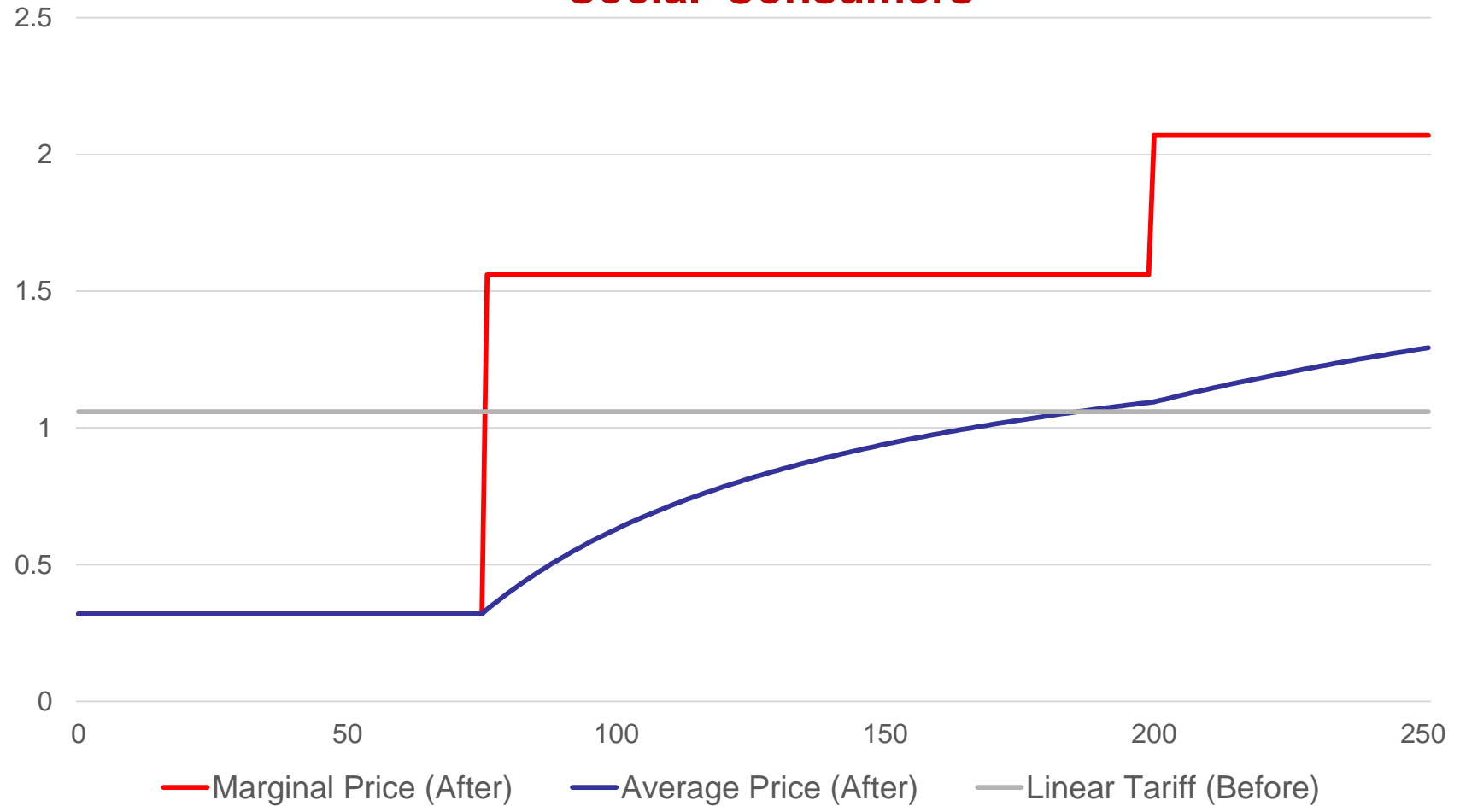 - No data on households' income (see extensions)

Case Study

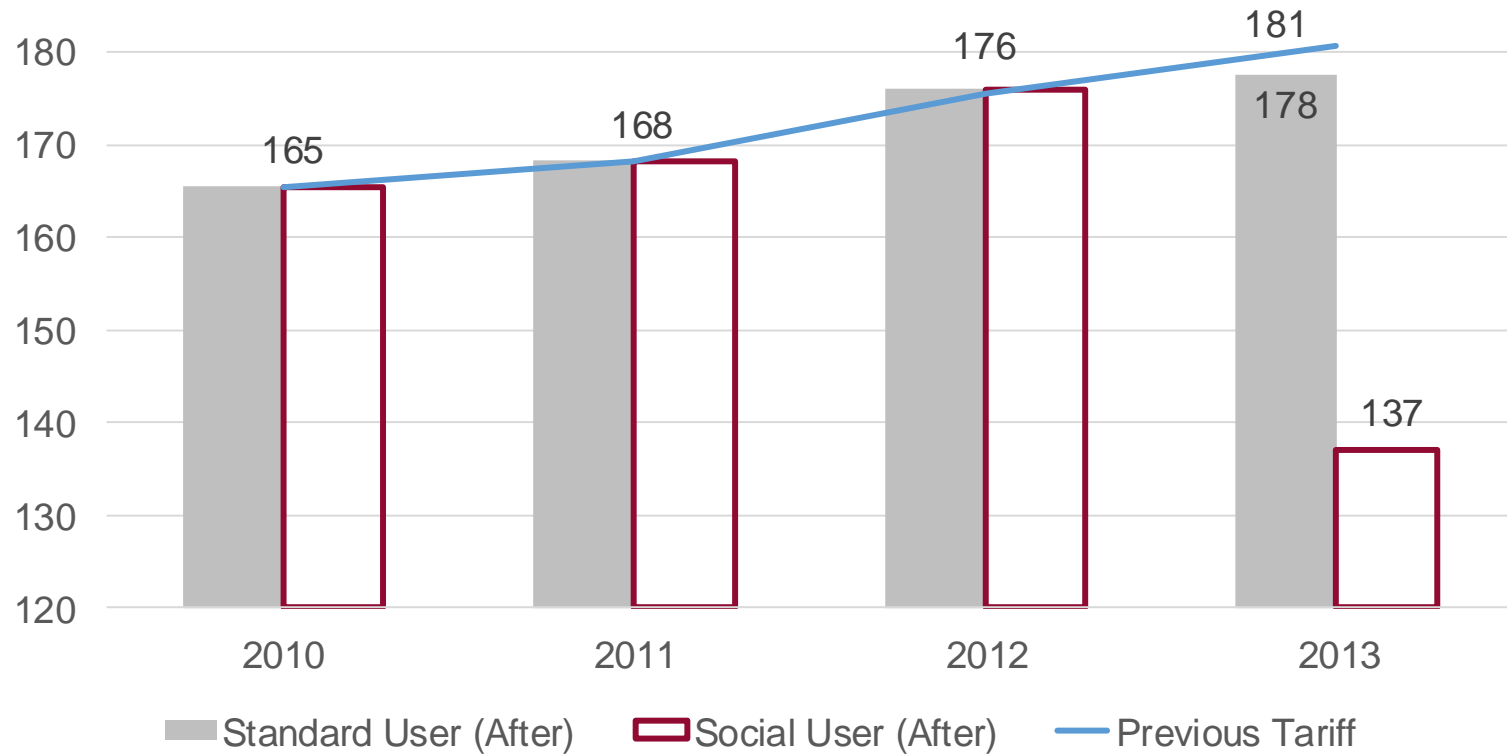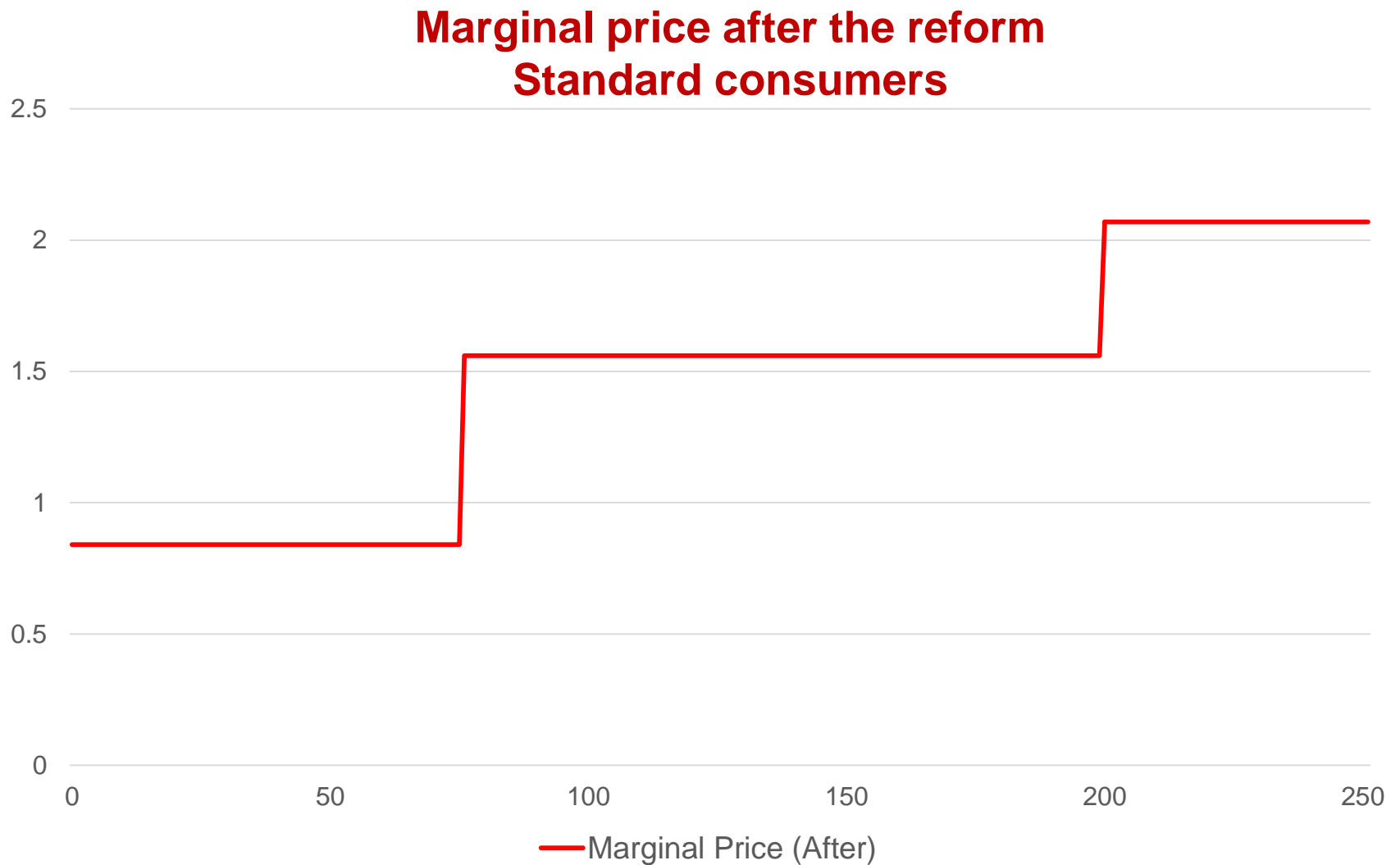## Marginal & average price before and after the reform
Standard consumers

Case Study

## Marginal & average price before and after the reform 'Social' Consumers

Legend: Marginal Price (After) — Average Price (After) — Linear Tariff (Before)

Case Study

Bills (incl. tax) before and after the reform

Do consumers bunch around kink points?

Marginal price after the reform
Standard consumers

Do consumers bunch around kink points?

**Marginal price after the reform
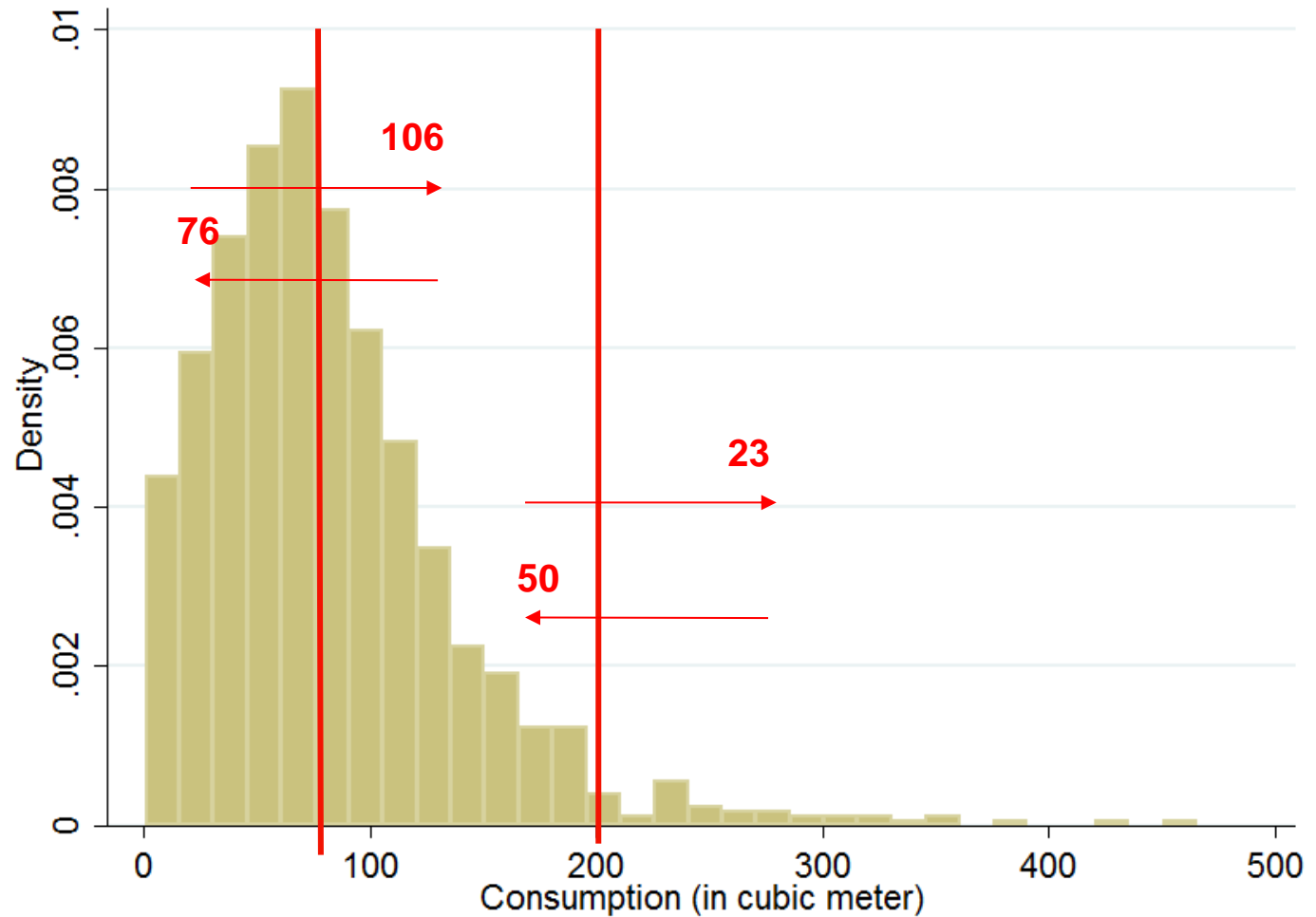Standard consumers**

Marginal Price (After)
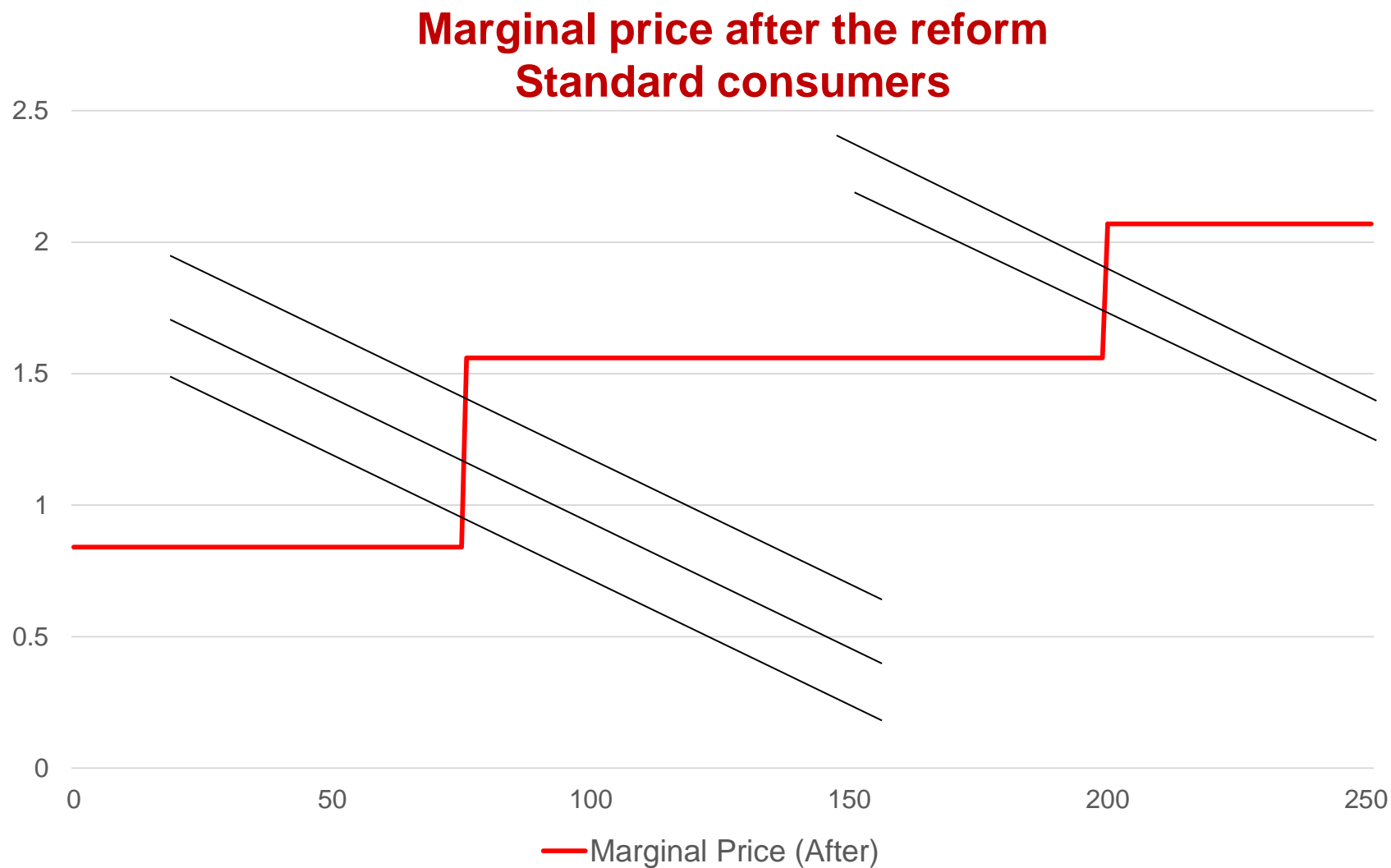
Do consumers bunch around kink points?

Consumption density in 2012
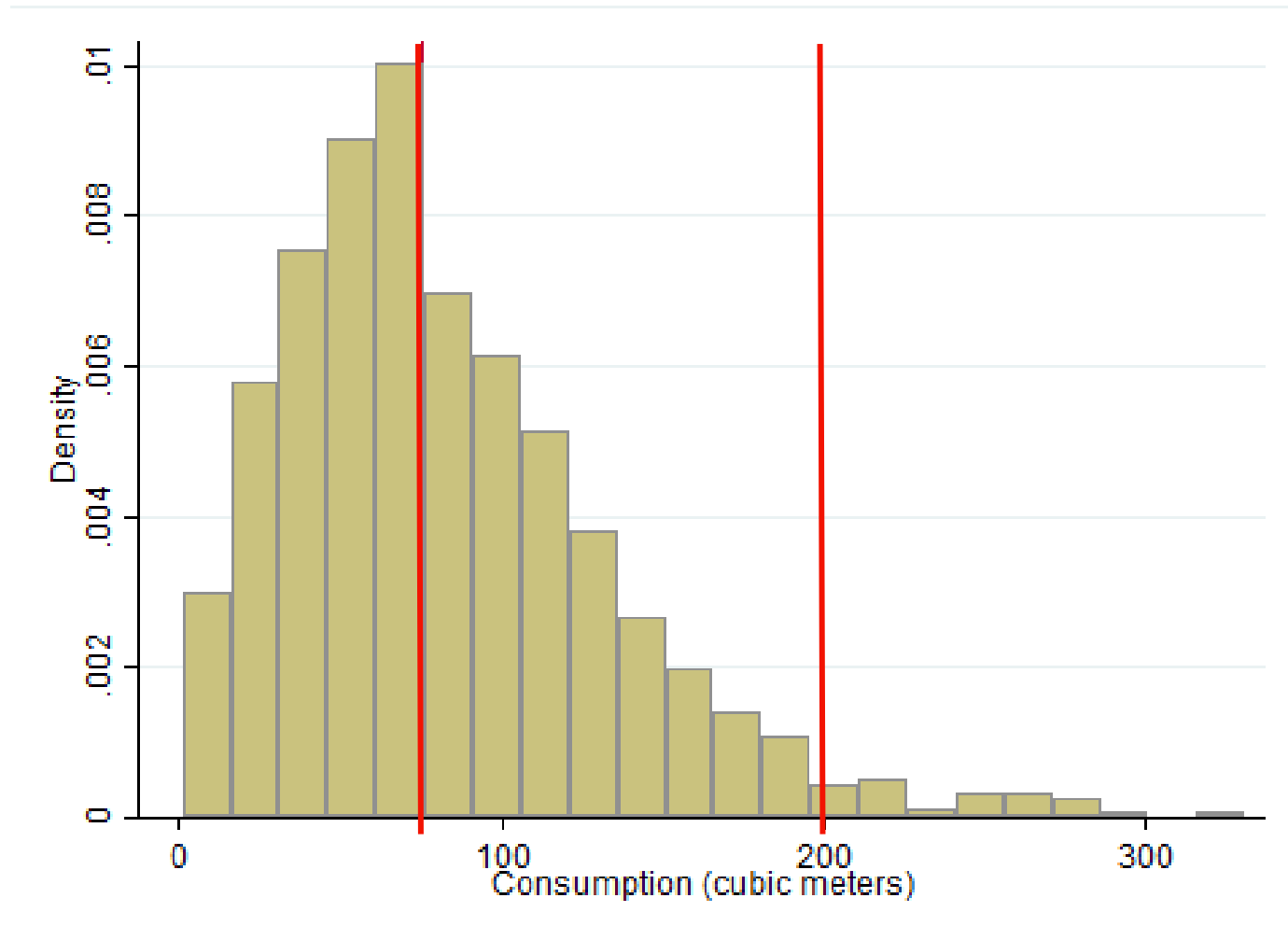
Do consumers bunch around kink points?

Consumption density in 2013

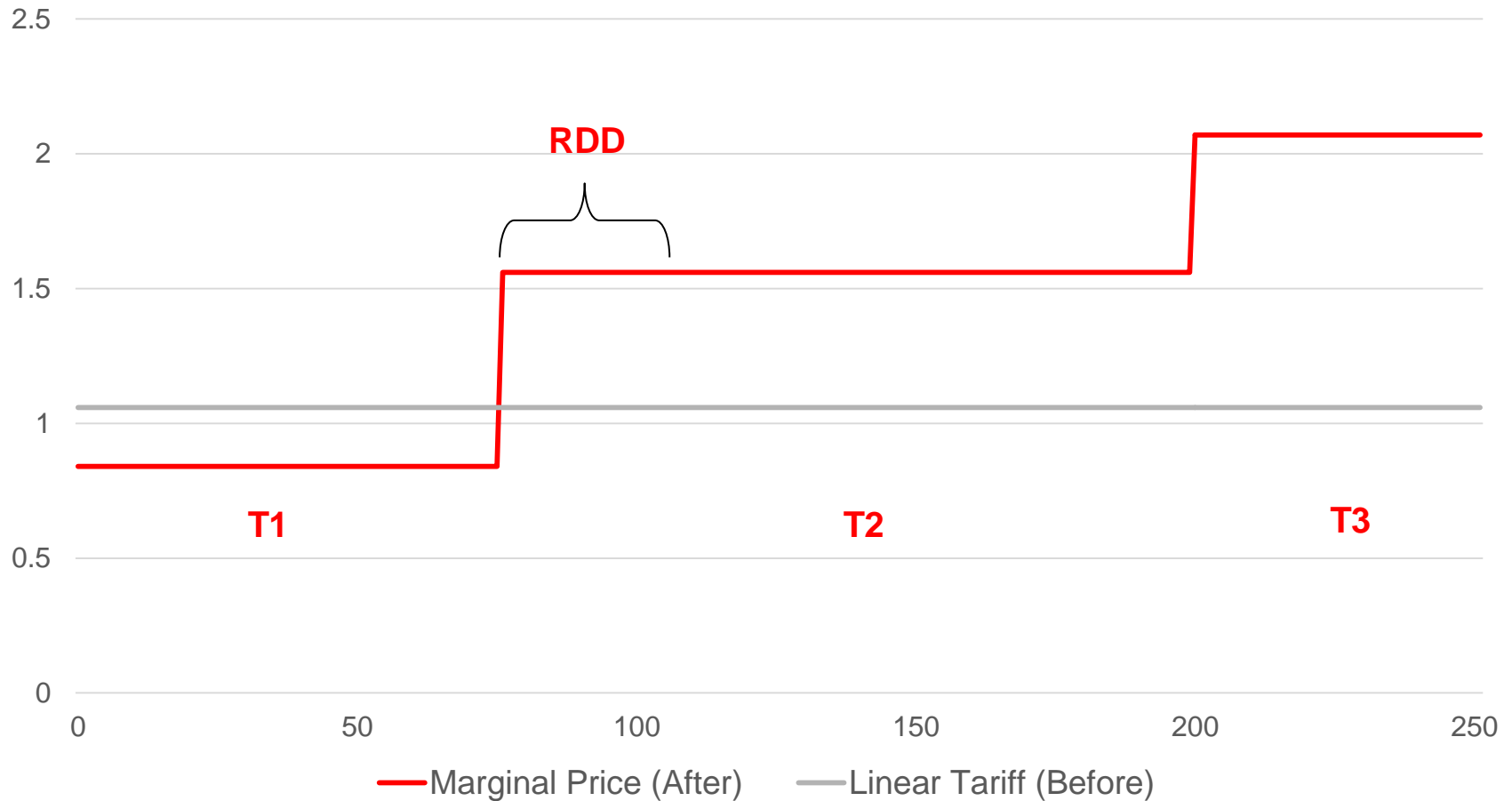# Consumers' response to change in marginal price

- The demand function can be described as

$$\Delta \ln C_{it} = \alpha_i + \beta \Delta \ln m p_t(C_{it}) + \varepsilon_{it}$$

- OLS would produce inconsistent estimates because the marginal price is a function of consumption

- Need to find a good instrument for the marginal price!

Consumers' response to change in marginal price

Marginal & average price before and after the reform
Standard consumers

Consumers' response to change in marginal price

- Another instrument for $\Delta \ln mp_t(C_{it})$ could be

    - $\Delta \ln emp_t = \ln emp_t(C_{it\text{-}1}) - \ln mp_{t\text{-}1}$

Consumers' response to change in marginal price

Instruments	Marginal Price Elasticity
RDD	-0.77***
$\Delta \ln emp_t$	-0.76***

Consumers' response to change in marginal price

- Higher estimates than in the literature

  - Espey, Espey & Shaw (1997) : -0.51
  - Hewitt and Hanemann (1995): -1.6
  - Olmstead et al. (2007): -0.64
  - Ito (2013): -0.1
  - Porcher (2014): -0.25

Consumers' response to change in average price

- Do consumers respond to marginal or average price?

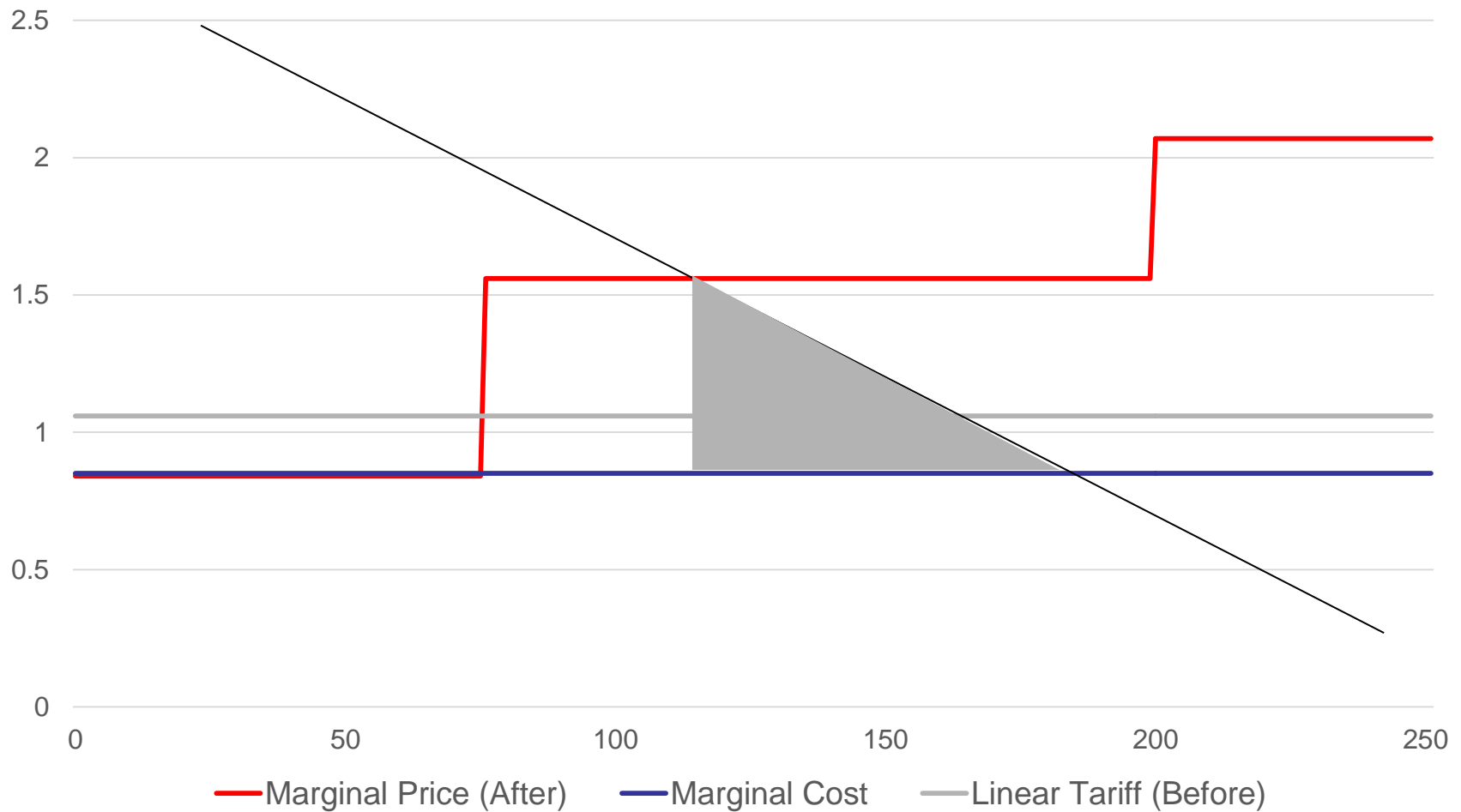$$\Delta \ln C_{it} = \alpha_i + \beta \Delta \ln ap_t(C_{it}) + \varepsilon_{it}$$

- We use the same instruments

  - RDD
  - $\Delta \ln eap_t = \ln eap_t(C_{it-1}) - \ln ap_{t-1}$

Consumers' response to change in average price

Instruments	Marginal Price Elasticity	Average Price Elasticity
RDD	-0.77***	-0.92***
$\Delta\ln emp_t$	-0.76***	-1.10***

Efficiency Costs

Deadweight loss with non-linear pricing

Legend: Marginal Price (After) — Marginal Cost — Linear Tariff (Before)

Efficiency Costs

Deadweight loss with a linear tariff

Legend: Marginal Price (After) — Marginal Cost — Linear Tariff (Before)
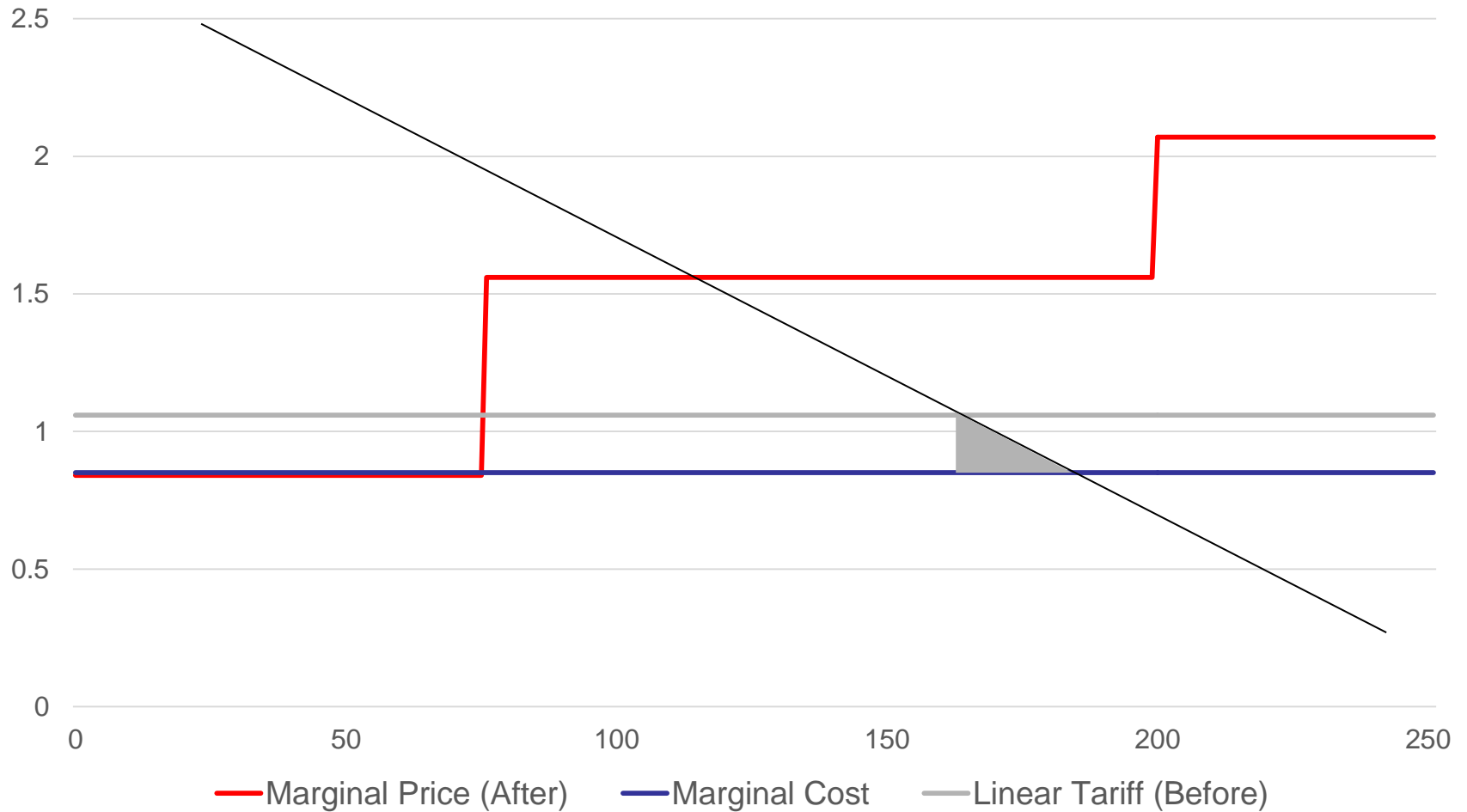
Efficiency costs

- Assuming that…

  - Consumers' elasticity is the same for all consumers (-0.75)
  - And mp is set up at the mp of the first tier
    - Reasonable as margins are around 20% (Porcher 2014)

- It is possible to benchmark efficiency costs:

  - Efficiency costs with linear price: 82,425 euros
  - Efficiency costs with non-linear pricing: 682,767 euros

Redistributional effects

	Welfare Gains	Efficiency Costs
First tier	+11.24 (5.18)	+11.36 (5.69)
Second tier	+11.94 (25.78)	+14.46 (4.37)
Third tier	-246.86 (-)	+90.21 (-)

- A simple Diff-in-Diff to improve our understanding

  - Using Calais as a control group

  - No detailed characteristics of households but observable consumption before & after the reform
    - Possible to match households with the same-level of consumption before the reform…
    - …and living in similar districts.

Extensions (in the making)

- Using customers' addresses & characteristics to match them with income data at the district level

  - Geolocalized data on incomes depending on different characteristics of households are avalaible at INSEE
    - e.g. a household of n persons living in district X earns on average W euros per year

  - Would give us better estimates of price elasticities & make the diff-in-diff more robust

Extensions (in the making)

- Computing the redistributional impact

    - Non-linear tariffs create a conflict between efficiency & distributional goals

    - With information on incomes, it would be easier to compute the redistributional impact of the policy
        - Already proxied using households eligible to social benefits
        - Get smoother info on the overall impact

Wrap-up

- Increasing-block tariffs

    - Decrease consumption for large consumers & vice versa

    - Have redistributional gains for small consumers

    - Have important efficiency costs

- Consumers react to marginal & average pricing

Wrap-up

- Results connected to

  - Mayol (2016): consumption increases for consumers in the first tier or consumers eligible to the social tariff (catch-up effect) & decreases for large consumers

  - Mayol (2016) uses a similar experiment by comparing houses and flats
    - Houses are individually metered before and after
    - Flats are metered in 2013
    - Impact of information (intrinsic motivation)

Thank you!
Comments welcome!